



## Appendix A: Estimation of Peak Hour Bus Needs

### Overall Methodology

The purpose of this calculation is to estimate the volume of bus trips that will be needed to carry the projected growth in transit trips from and in the Seattle Center City (PM peak hour). The calculation begins with given modeled estimates of growth in transit trips. The estimates reflect a policy of only modest growth in vehicle trips. Applying a PM peak hour percentage assumption yields the number of transit person trips to accommodate in the peak hour. Since this number would be carried by all modes, including the various rail modes operating within downtown, we next estimate and subtract out the ridership on each of the rail transit services that are assumed to be in operation in our study year, 2015. The result is an estimate of the volume of trips that must be carried on buses, which we then translate into the number of one-way bus-trips required.

### Projected vs. Minimal Estimates

To provide a range of estimated bus needs, we used a low and high estimate of the number of trips handled by each non-bus mode -- Monorail, Central Link LRT, S. Lake Union Streetcar, and Sounder Commuter Rail. These estimates are then subtracted from the total transit trip demand to yield an estimate of the number of trips that must be carried on buses, which in turn leads to the number of bus trips required.

The two estimates differ based on the assumption made about the non-bus modes:

- “Projected” figures for bus needs are derived using the most recent ridership projections for each non-bus mode from each sponsoring agency.
- “Minimal” figures for bus needs are derived by assuming that each non-bus mode operates at its maximum possible capacity. Capacity is higher than actual projected ridership, so the capacity-based estimate, when subtracted from total demand, yields a low-end estimate of bus needs. We call this estimate “Minimal” because it indicates the physical limits of those modes, so the resulting bus volume estimate is an absolute lower limit even if non-bus ridership estimates are exceeded.

Note that while the Minimal estimate is an absolute lower limit to bus needs, the Projected estimate is not an absolute upper limit. In fact, if ridership failed to meet estimates on any of the non-bus services, or if any of these services are not fully built as planned, then the bus volumes could go higher than the Projected estimate. For this reason, the Projected estimate is the better number to use for planning purposes, though if one wants to be as optimistic as possible about the potential ridership of non-bus modes, the Minimal shows how many buses must still be accommodated downtown.

	Row #			Explanation and Sources (See Appendix A for further detail)
<b>Estimate of Marginal Peak Hour Transit Trips from/in Center City</b>				
Weekday Person Transit trips from/in Seattle CC, 2002 (trips)	1	194,163		From modeling performed in conjunction with AWW project
Weekday Person Transit trips from/in Seattle CC, 2015 (trips)	2	356,014		Extrapolated AWW model which provides figure for 2030 (542,765). Assumes straight-line growth
Marginal (New) Person Transit trips from/in Seattle CC, 2015 (trips)	3	161,851		Difference between 2015 transit trips and 2012 transit trips (Row 2 – Row 1)
Percent of Transit Trips in a Peak Hour	4	15%		Estimated percentage based on review of various trip generation data and general concentration of transit trips in peak periods
<b>Marginal Transit Trips in Peak Hour, 2015</b>	<b>5</b>	<b>24,278</b>		The peak hour percentage applied to the marginal transit trips. (Row 3 x Row 4)
<b>Marginal Transit Trips in Non-Bus Modes, Peak Hour</b>		<b>Projected Scenario</b>	<b>Minimal Scenario</b>	
Monorail Green Line	6	3,700	5,400	From SMP Green Line, Draft Environmental Impact Statement, 8/03.
Central Link (LRT)	7	3,060	3,240	Based on figures from Draft DSTT Joint Operations Plan.
S. Lake Union Streetcar	8	417	1,125	Based on estimates in SLU Streetcar Draft Final Report prepared the City and Parsons Brinckerhoff in 2003.
Sounder Commuter Rail	9	3,542	4,723	Based on future operational assumptions outlined by Sound Transit (See <a href="http://www.soundtransit.org/sounder/sounder.htm">www.soundtransit.org/sounder/sounder.htm</a> )
<b>Total Non-Bus Person Transit Trips - Peak Hour</b>	<b>10</b>	<b>10,718</b>	<b>14,488</b>	Sum of all Non-Bus Transit modes. (Sum of Rows 6-9)
<b>Estimate of Bus Requirements</b>		<b>Projected</b>	<b>Minimal</b>	
New Bus Person Transit Trips - Peak Hour	11	13,559	9,789	Subtraction of non-bus transit trips from all peak hour transit trips (Row 5 – Row 10)
Passengers from/in Center City per Bus Vehicle Trip	12	40	40	Various data sources show this figure to range from 39-41
New Bus Vehicle Trips Needed, Peak Hour	13	339	245	New Bus Person Transit trips divided by passengers per vehicle (Row 11 / Row 12)
<b>Total Bus Trips Needed, Peak Hour, 2015</b>	<b>14</b>	<b>954</b>	<b>860</b>	Sum of new bus vehicle trips and current approximately 615 peak hour buses (13 + [615])
<b>Number of Surface Bus Trips Needed, Peak Hour, 2015</b>	<b>16</b>	<b>834</b>	<b>740</b>	The total bus trips needed minus the 120 bus trips per hour that the tunnel will accommodate with Central link (14 - [120])

## Bus Load Factor Estimate

To calculate the estimated one way bus trips needed per peak hour, we take the projected one-way person trip that remains after non-bus mode ridership is subtracted, and divide this by the projected average load of a bus. Our assumption for average load is 40 passengers/bus, which is quite high, so as to produce a conservative estimate of the number of buses required. In general, 40 passengers fill all the seats of a standard coach or about 2/3 of the seats of an articulated coach. Since many buses will be running through downtown in a non-peak direction that will generate much less demand, these relatively empty buses average out with other crush-loaded buses to yield this estimate.

## Sources of Estimates for Non-Bus Modes

### Monorail

#### Ridership Estimate (yielding Projected bus volume)

PM Peak hour ridership by station is presented in pages 4-28 to 4-31 in the DEIS. It represents boardings and alightings from the Belltown station to the Weller/King station. Those trips expected with access/egress the Monorail by transferring to bus or rail downtown are subtracted from this estimate, since these trips will still count against the total intra-downtown bus needs, or as part of the ridership of other rail modes.

#### Capacity estimate (yielding Minimal bus volume)

Capacity is 6,000 persons per hour (200 per train x 15 trains per hour) given initial operations of 4 minute frequency. This number is reduced by only 10% to account for transfers and non-Center City trips.

### Central Link LRT

#### Ridership Estimate (yielding Projected bus volume)

Estimates are for a maximum line load of 2,100 passengers/hour in 2010 and 3,020 passengers/hour in 2020. The midpoint of 2,560 was used for 2015. Since this is the peak direction, a high estimate of 500 reverse peak riders was added to this figure.

#### Capacity Estimate (yielding Minimal bus volume)

Current plan is to use 2-car vehicles with peak frequency of 6 minutes. A fully loaded car of 137 passengers, x 2 cars per train, x 10 trains per hour yields 2,740 passenger capacity per hour in peak direction. The 500 reverse peak rider assumption was added to this figure.

### S. Lake Union Streetcar Estimation

#### Ridership Estimate (yielding Projected bus volume)

Range of 2005 daily ridership in forecast is 1,900 to 3,000. An average (2,450) is used which can also be considered as accounting for bus transfers. A growth factor of 1.26% annually from AWW modeling is applied to grow the forecast from 2005 to 2015 (2,477). Then the 15% peak period assumption is applied.

#### Capacity Estimate (yielding Minimal bus volume)

Typical capacity is a design load of 154 with a crush load of 221; midpoint (188) is used. Assumed frequency of 10 minutes (6 trips per hour) yields the peak hour capacity projection.

## Sounder Commuter Rail Estimation

Sounder terminates at the south end of downtown, so it does not provide intra-downtown service. Here the question is what percentage of Sounder riders will transfer to buses or other rail to complete their downtown trip, thus generating a one-way bus trip or counting as part of the ridership on one of the other rail lines. The Projected estimate assumes 40% of riders transfer to bus or other rail, the Minimal estimate assumes only 25% transfer do so. In each case, the remainder are presumed to reach their destinations by walking or cycling.

Both estimates are then applied to the capacity of Sounder as currently planned. Trains will average 7 car lengths. Capacity is 140 per car. 3 trains per hour will generally operate, along 2 corridors. Thus 7 cars x 140 seats x 3 trains x 2 corridors = 5,904 person trips per hour.